REMARKS

Claims 38, 45-59, and 62-63 are pending in the present application. In the Office Action dated May 3, 2005, claims 38 and 45-59 were rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,362,510 to Gardner et al. ("the Gardner patent").

The embodiments disclosed in the present application will now be discussed in comparison to the cited references. Of course, the discussion of the disclosed embodiments, and the discussion of the differences between the disclosed embodiments and the cited references, do not define the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner appreciate important claim distinctions discussed thereafter.

The embodiments disclosed in the present application are directed to processes and devices including selectively formed contacts for electrically interconnecting components on an integrated circuit. The contacts have an increased vertical growth rate relative to a lateral growth rate during formation of the contacts. In this way, adjacent contacts may be formed in integrated circuits having reduced dimensions since the lateral growth rate of the contacts will not cause adjacent contacts to electrically short circuit. Figure 2 of the present application illustrates an overall process of selectively forming contacts 200-204 on a substrate 206 according to one embodiment of the present invention. To begin the process, a selective epitaxial growth (SEG) process is started, causing the contacts 200-204 to begin forming over the regions 214-218, respectively. At the same time, electromagnetic radiation 208, or some other type of directed thermal energy, is applied to begin heating upper surfaces 220 of the contacts 200-204. The radiation 208 heats the upper surfaces 220, causing a vertical growth rate 226 of each contact 200-204 to increase relative to a lateral growth rate 228 of the contact. The lateral growth rates 228 of each contact 200-204 do not increase significantly because the intensity of the radiation on sidewall surfaces 222, 224 is small relative to the intensity on the upper surfaces 220. As a result, the contacts 200-204 grow at a faster rate in the vertical direction 226 than in the lateral direction 228. The relatively smaller lateral growth rate 228 results in less lateral growth of each contact 200-204 during the time the contact is being formed. The reduced lateral growth rate 228 relative to the increased vertical growth rate 226 enables contacts 200-204 to be selectively formed having a desired height H in semiconductor integrated circuits having reduced lateral spacing between devices. As seen in the example of Figure 2, the

reduced lateral growth of the contacts 200 and 202 results in the contacts being formed only slightly over the isolation oxide region 210, while the increased vertical growth rate 226 enables the contacts to be grown to the desired height H. In Figure 2, the surfaces that are significantly heated by the applied radiation 208 are indicated via the thicker lines.

Accordingly, each contact 200-204 exhibits a single crystalline structure due to being epitaxially grown, and an arcuate, convex upper surface 220 and sidewall surfaces 222, 224 that are substantially perpendicular to the substrate 206. Thus, the resulting contact 200-204 exhibits a structure that is different than that of a conventionally formed contact shown in Figure 1.

The Examiner has cited the Gardner patent. The Gardner patent is directed to forming a transistor in a silicon epitaxially grown layer. As shown in Figures 1-10, the transistor is formed in a semiconductor substrate 100 having an oxide layer 102 with a groove 104 defined therein. A silicon epitaxial layer 104 is deposited within a groove 104 defined in the upper oxide layer 102 and not upon the oxide layer 102. During subsequent processing steps, source and drain regions 128 of the transistor are formed in the silicon epitaxial layer 104 and a gate structure 120 is formed over a channel region between the source and drain regions 128.

Of particular relevance is the process and resulting structure of the silicon epitaxial layer 104 formed in the groove in the oxide layer 102. The Gardner patent expressly discloses that the silicon epitaxial layer 104 has a planar upper surface and preferably that the upper surface is coplanar with the upper surface of the oxide layer 102. For instance, the Gardner patent states that "[s]ilicon epitaxial layer 106 is preferably grown until its upper surface is substantially coplanar with the upper surfaces of adjacent portions of oxide layer 102." (Column 8, lines 43-45). Again, the Gardner patent states that "[t]he epitaxial growth process is preferably terminated when the upper surface of the silicon epitaxial layer 106 is coplanar with the upper surface of oxide layer 102. Since these upper surfaces are coplanar after formation of the epitaxial layer is complete, there is preferably no need to planarize either of them." (Column 8, lines 56-61).

Accordingly, the Garnder patent discloses that the silicon epitaxial layer 106 has a planar upper surface and the growth process may be terminated at a point so that the planar upper surface of the silicon epitaxial layer 106 is coplanar with the upper surface of the oxide layer

102. First, it is clear that the upper surface of the silicon epitaxial layer 106 is not arcuate and convex. Second, the silicon epitaxial layer 106 cannot fairly be considered "a contact" in the context of the semiconductor device arts. Instead, the silicon epitaxial layer 106 forms the transistor itself and not an electrical contact that is to be electrically coupled to the source/drain regions 128. Third, the Gardner patent does not disclose that a selectively formed single crystal contact is formed on each source/drain region 128 and each selectively formed single crystal contact having an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to an upper surface of the substrate 100. Fourth, the Gardner patent does not disclose or fairly suggest a selectively formed single crystal contact that extends past the contact or active region that it is formed on and over only a peripheral region of an adjacent non-contact or isolation region.

While the Gardner patent discloses forming the silicon epitaxial layer 104 using selective epitaxial growth, no incident electromagnetic radiation, or some other type of directed thermal energy, is applied to heating upper surfaces of the silicon epitaxial layer 104 during formation to result in a high aspect ratio structure having an arcuate, convex upper surface with generally planar sidewalls that are perpendicular to the semiconductor substrate 100. Instead, the Gardner patent merely employs conventional selective epitaxial growth using a conventional reactor that heats the substrate 100 using infrared (IR) or radio frequency (RF) heating and makes no mention of using a directed electromagnetic source of energy to heat the upper surface of the silicon epitaxial layer 104 during epitaxial growth. Contrary to the Examiner's assertion that the side walls of the silicon epitaxial layer 106 are heated to a lesser extent than the upper surface of the silicon epitaxial layer 106, heating the substrate 100 including the silicon material being grown thereon to form the silicon epitaxial layer 106 in a conventional reactor will uniformly heat the substrate 100 and the layer 106 so that both the side walls and upper surface of the layer 106 are at approximately the same temperature to form the layer 106 with a planar upper surface and side walls. Therefore, the disclosure of the Gardner patent does not establish that the silicon epitaxial layer, as processed, necessarily has an arcuate, convex upper surface with generally planar sidewalls that are perpendicular to the semiconductor substrate 100. Again, since the Gardner patent makes no mention of using a directed electromagnetic source of energy to heat the upper surface of the silicon epitaxial layer 104 during epitaxial growth, it is

not inherent in the disclosure of the Gardner patent that the silicon epitaxial layer would necessarily exhibit an arcuate, convex upper surface with generally planar sidewalls.

In summary, in addition to other deficiencies, the Gardner patent fails to disclose, either expressly or inherently, a selectively formed single crystal contact having an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to the surface of the substrate. In fact, based upon both the express and implicit teachings of the Gardner patent, the layer 106 that is used to purportedly show an electrical contact has a planar upper surface.

Turning now to the claims, the patentably distinct differences between the cited references and the claim language will be specifically pointed out. Claim 38 recites "[a]n in-process substrate structure including a plurality of contact regions and a plurality of non-contact regions adjacent the contact regions on a surface of the substrate, the in-process substrate structure comprising: a selectively formed single crystal contact on each single crystal contact region, each single crystal contact being isolated from single crystal contacts on adjacent contact regions, each single crystal contact having *an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to the surface of the substrate.*" (Emphasis Added). As discussed in more detail above, the Gardner patent fails to disclose or fairly suggests a selectively formed contact having a single crystal structure and further having an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to the surface of the substrate as required by claim 38.

Claims depending from claim 38 are also allowable due to depending from an allowable base claim and further in view of the additional limitations recited in the dependent claims. For example, new claim 62 recites "the selectively formed single crystal contact extends past the contact region and over only a peripheral region of one of the adjacent non-contact regions." The Gardner patent fails to disclose such limitations. In fact, it teaches away by forming the silicon epitaxial layer 106, relied upon by the Examiner as a selectively formed single crystal contact, with in the groove 104 in the oxide layer 102 and the layer 106 does not extend over the adjacent oxide layer 102.

Presently amended claim 52 recites "[a]n in-process semiconductor structure, comprising: a substrate including a plurality of transistors, each transistor including a pair of active regions formed within the substrate and having a channel region defined between each pair of active regions, a plurality of isolation regions adjacent the active regions, each isolation region being positioned between adjacent active regions to isolate adjacent active regions; and *at least one selectively formed single crystal contact formed on each active region, each selectively formed single crystal contact being isolated from single crystal contacts on adjacent active regions, each selectively formed single crystal contact having an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to an upper surface of the active region.*" (Emphasis Added). Again, the Gardner patent fails to disclose or fairly suggest a selectively formed contact having a single crystal structure and further having an arcuate, convex upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to an upper surface of the active region as required by claim 52. Furthermore, the Gardner patent does not disclose an electrical contact having the geometry required by claim 52 that is formed on each pair of active regions of a transistor.

Claims depending from claim 52 are also allowable due to depending from an allowable base claim and further in view of the additional limitations recited in the dependent claims. For example, new claim 63 recites "the at least one selectively formed single crystal contact extends past the active region and over only a peripheral region of one of the adjacent isolation regions." The Gardner patent fails to disclose such limitations. Again, it teaches away by forming the silicon epitaxial layer 106, relied upon by the Examiner as a selectively formed single crystal contact, with in the groove 104 in the oxide layer 102 and the layer 106 does not extend over the adjacent oxide layer 102.

All of the claims remaining in the application (claims 38 and 45-59) are now clearly allowable. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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